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The effect of complex exercise rehabilitation program on body composition, blood pressure, blood sugar, and vessel elasticity in elderly women with obesity

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The purpose of this study is to identify what kind of effects complex exercise rehabilitation program has on body composition of female, blood pressure, blood sugar, blood vessel elasticity and find more effective complex exercise program for elderly females. The subjects are selected 30 females applicants in exercise program in City of G and not restricted in mobility to perform the exercise without any particular disorders. Exercise program is a combination of aerobic and strength training with different ratio, for the first 6 months focused on strength training complex exercise, and for next 6 months focused on aerobic exercise. Except for strength training and aerobic exercise, durations for strength, rest, and wrapping-up are equal. The frequency of experiments is 90 min each, 2 times per a week. Body composition, blood pressure, and blood vessel elasticity are tested pre and post experiment to compare the effectiveness of both complex exercises. As results, in the complex exercise program focused on strength training, weight, percent body fat, fat mass, waist hip ratio, systolic blood pressure, and diastolic pressure increased. Blood vessel elasticity maintained its level or slightly decreased. In the complex exercise focused on aerobic exercise, weight, percent body fat, fat mass, waist hip ratio, systolic pressure, and diastolic pressure decreased. Blood vessel elasticity on left foot and right foot are slightly different. Therefore, aerobic exercise is more effective than strength training for old obese females.

Keywords: Physical rehabilitation, Complex exercise, Elderly women, Obesity

INTRODUCTION

As medical technologies have developed in modern society, average human life span has been gradually extended and mortality rate has been decreased, so the number of old people is increasing worldwide (Hyung and Kim, 2001). As a result, issues in aging of population along with maintaining the quality of life have become serious problems (Hong et al., 2005). The proportion that the elderly population takes is rapidly increasing in Korea. According to the statistics in 2007, average lifespan of male is 75.1 yr. Healthy lifespan of male, which means duration of life to live healthy without any psychological or physical discomfort, is 67.5 yr. Also, average lifespan of female is 81.9 and healthy lifespan is 69.9. Average life span for women is 6.8 yr longer and healthy life is 4.4 yr longer than men. Thus, for women who have longer life span has to maintain longer unhealthy life than men (Hyung and Kim, 2001).

Chronic diseases in old age, obesity, physical impairment, cognitive decline are preventive through exercises. Exercises will make healthy lifespan longer, so senior citizens can live longer with better quality of life. However, since senior citizens have weakened joints and physical abilities, it is very important to find the proper exercise programs for them. Senior exercise programs basically need aerobic exercise, which promote physical stamina, immune system, and cardiac output. As a result, the frequency of cardiac diseases decreases by activating cardiac circulations. Also, during se-

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nescence, muscles are atrophied in old age, so the abilities of muscular tissues to maintain its' positions gets degraded due to the weakened muscle strength. As a result, muscles in the chest bent inside resulting in limitation of breathing due to elevated pressure in the chest. This phenomenon will lower the oxygen intakes. Therefore, degradation in the brain and hearts will be observed. Also, neuralgia could be one of the problems. To sum up, proper level of muscular exercise for senior citizens has become essential, now.

Thus, seniors exercise programs of aerobic exercise and strength exercise all play important roles. Thus, the development and research in the complex exercise programs in recent years have been active, but the complex exercise program suitable for elderly women has not been established. In this study, we are to see what ratio between aerobic exercise and strength training exercise program for obese elderly women is more effective rehabilitation programs compares to other programs.

MATERIALS AND METHODS

Subjects

The subjects of this study are selected 30 females applicants in exercise program in City of G and not restricted in mobility to perform the exercise without any particular disorders. The physical characteristics of the subjects are shown in Table 1.

Design of experiments

To evaluate the effectiveness of complex exercise which combines strength exercise and aerobic exercise, we experimented to the same subjects for 6 months with strength exercise focused exercise, and after that we did the complex exercise focused on aerobic exercise. Both experiments were carried out twice a week 90 min each, except for strength training and aerobic exercise, duration of stretching and recess, organized movement were identical. In addition, body composition before and after the beginning of the experiment, blood pressure and vascular compliance were conducted to compare the effectiveness of two complex exercises.

Experimental procedures and measuring methods

Body composition

Measuring the height using extensometer and weight, body fat percentage, body fat mass, lean body mass, abdominal fat rate and muscle mass using Inbody (Olympia 3.3: Jawon Medical Co., Gyeongsangbuk-do, Korea).

Table 1. The physical characteristics of the subjects

Age (yr)	Height (cm)	Weight (kg)	Body fat (%)
69.97 ± 6.32	152.87 ± 5.19	58.6 ± 9.93	33.64 ± 3.34

Blood pressure

Measuring systolic blood pressure and diastolic blood pressure using sphygmomanometer (FT-500R: Jawon Medical Co., Gyeongsangbuk-do, Korea) after stabilizing subjects for more than 10 min.

Vessel elasticity

Measuring pulse wave velocity using Pulse Wave Velocity 3.0 (KM Tec., Anyang, Korea). All metallic materials such as necklaces, rings, watches, etc. were removed before measurement. 2 EKG Electrodes on the left forearm and 1 on the right forearm in a supine position for stability, attaching pulse and sensor to the thumb for upper limbs measurement, and then, to the big toe for lower limbs measurement.

Making subjects do not move or say during measurement, calculating the average value from the selected confidence interval of 20 sec among the automatic measured data of 30 sec.

Exercise program

Exercise program is a combination of aerobic and strength training with different ratio, for the first 6 months focused on strength training complex exercise, and for next 6 months focused on aerobic exercise. Except for strength training and aerobic exercise, durations for strength, rest, and wrapping-up are equal. The frequency of experiments is 90 min each, 2 times per a week. The Exercise program is shown in Table 2.

Data processing

The average and standard deviation to all variables of collected data was calculated using SPSS (version Statistics 19) program. Analysis of each compound by comparing before and after the rehabilitation program was done for the elderly obese women to determine the effect and we used paired sample t-test was run. And all statistical significance level was set to $P < 0.05$.

Table 2. Exercise program

Complex exercise which combines strength exercise		Complex exercise which combines aerobic exercise	
Stretching	15 min	Stretching	15 min
Anaerobic exercise	40 min	Aerobic exercise	40 min
Relaxation	10 min	Relaxation	10 min
Aerobic exercise	15 min	Anaerobic exercise	15 min
Warm-down	10 min	Warm-down	10 min

Table 3. Changes in body composition

Variables	Before mean±SD	Complex exercise which combines strength exercise			Complex exercise which combines aerobic exercise		
		Mean±SD	t	*P*	Mean±SD	t	*P*
Weight	58.6±9.93	59.41±10.17	-3.224	0.003	58.78±9.99	2.93	0.007
Body fat percentage	33.64±3.34	34.39±3.54	-3.136	0.004	33.91±3.61	2.481	0.019
Body fat mass	20.3±5.82	21.46±6.61	-3.176	0.004	20.54±5.94	2.242	0.033
Lean body	38.63±5.07	38.69±5.06	-0.454	0.653	38.57±5.03	0.705	0.486
Abdominal fat rate	0.914±0.039	0.924±0.0429	-3.474	0.002	0.918±0.0449	2.819	0.009
Muscle mass	35.31±4.55	35.34±4.53	-0.213	0.833	35.24±4.52	0.573	0.571

Table 4. Changes in blood pressure

Variables	Before mean±SD	Complex exercise which combines strength exercise			Complex exercise which combines aerobic exercise		
		Mean±SD	t	*P*	Mean±SD	t	*P*
Systolic blood pressure	124.1±14.83	136.67±20.88	-4.223	0.000	124.55±13.55	3.533	0.001
Diastolic blood pressure	71.13±9.24	80.67±10.23	-6.152	0.000	70.93±8.62	5.56	0.000

Table 5. The result of vessel elasticity

Variables	Before mean±SD	Complex exercise which combines strength exercise			Complex exercise which combines aerobic exercise		
		Mean±SD	T	*P*	Mean±SD	t	*P*
Variables left hand of upper limb	214.05±38.84	205.92±23.91	1.26	0.218	213.24±21.19	-2.345	0.026
Right hand of upper limb	209.34±22.84	208.68±25.35	0.189	0.852	231.94±64.09	-1.805	0.082
Left foot of lower limb	258.23±31.03	258.95±33.55	0.39	0.699	268.06±28.23	-2.443	0.021
Right foot of lower limb	258.37±31.45	255.18±32.69	0.564	0.577	265.66±21.54	-2.899	0.007

RESULTS

Changes in body composition

The weight was increased by 0.77 kg ($P<0.01$) in the strength focused exercise group, and decreased by 0.65 kg ($P<0.01$) in the aerobic focused exercise group compared to pre-exercise (Table 1).

The body fat percentage was increased by 0.75% ($P<0.01$) in strength focused exercise, and decreased 0.52% ($P<0.05$) in aerobic focused exercise compared to pre-exercise (Table 2). The total body fat was increased by 1.16 kg ($P<0.01$), and decreased by 0.97 kg ($P<0.05$) in aerobic focused exercise group compared to pre-exercise. However, total body fats were no significant difference both groups (Table 3).

Changes in blood pressure

The result of changes in blood pressure, when focused on the strength exercise, the systolic blood pressure 12.57 mmHg ($P<0.001$) increased compared to the aerobic exercise with decreased Diastolic blood pressure of 12.12 mmHg ($P<0.001$) (Table 4). There was no significant difference complex exercise which combines strength exercise and which combines aerobic exercise.

Change in vessel elasticity

Changes in pulse wave velocity, when focused on the aerobic exercise, the left foot of lower limb 9.11 ms ($P<0.05$) and right foot of lower limb 10.48 ms ($P<0.01$) were increased (Table 5).

The aerobic exercise was the significant differences in foot of lower limb, but the strength exercise was the no significant differences and changes in pulse wave velocity decreased. It seems that the aerobic exercise effects significantly to the change of pulse wave velocity according to the significant differences.

DISCUSSION

Body composition

Since postmenopausal women have increased prevalence of many diseases due to physical changes in the later middle ages compare to men, steady exercise has been emphasized to prevent obesity and proper body composition (Smetnik and Shestakov, 2003).

Gavrilov et al. (2002) experimented obese patients with two different groups, one is with a combination of diet and exercise and the other is only with diet, so proved that there is a significant decrease in fat mass in both groups. However the group only

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with diet, fat mass was not decreased but only lean mass decreased. Therefore, both diet and exercise should be combined. Also, Depres (1992) stated that regular aerobic exercise without diet may reduce body fat and prevent reduction in lean mass. Also, forcing excessive diet to elderly women causes reduction in lean mass, so loss of protein brings out cardiac disorders and severe risk in health (Beyul and Budagovsky, 1992). Thus, we decided to do only with exercise without recommending diet.

In this study, the complex exercise focused on strength exercise, there was a significant increase in weight, body fat, and abdominal obesity and on the other hand lean mass increased and muscle mass slightly reduced.

In the complex exercise focused on aerobic exercise, weight, body fat percentage, abdominal obesity were significantly decreased, but lean mass and amount of muscles were decreased but not significant. The result of reduction in weight, body fat percentage and abdominal obesity were identical to the result of Lee et al. (2009). Also, it was similar to Lee and Lee (2006) who experimented the complex exercise with obese middle aged women as weight, body fat percentage, and total body fat were reduced, and lean mass stays the same. Also, no changes in lean mass and total amount of muscles were similar to Hyung et al. (2008) and the experiment on middle aged women in suburban area after working on aerobic exercise.

Therefore, changes in body composition from aerobic focused exercise was more effective, to the women who need to lose weight, than strength focused exercise in reduction of the weight, body fat percentage, and total body fat. Also, the reason why the lean mass and amount of muscles were not significantly different was that the level of exercise for the elderly women was not intense. Therefore, if the objects need to increase the strength, we'd like to recommend that increasing the intensity of circuit training or regular exercise could be a good option.

Blood pressure

Elderly women have increased pulse and blood pressure compare to young people. However, exercise decreases the blood pressure and gives positive effects (Jeon et al., 2010). During exercise, changes in blood pressure is due to the activation of sympathetic nerves and the reduction of parasympathetic nerve stimulation which causes increase in the systolic pressure but the diastolic pressure maintains it's level. However, exercise causes drops in both systolic and diastolic pressure (Martynov, 2007).

In this study, people with strength focused exercise dropped systolic pressure by 13 or 14 mmHg and diastolic by 9.93 mmHg. People with aerobic focused exercise dropped systolic pressure by 11.97 mmHg, and diastolic by 9.38 mmHg which is identical to the results from Kang et al. (2012) who experimented with both diet and complex exercise at the same time, and identical to the result from Kang et al. (2010) who experimented aerobic exercise for 12 weeks on elderly patients with hypertension. However, the results for diastolic pressure were different. Likewise, complex exercise focusing on strength exercise is better to decrease blood pressure compare to the aerobic exercise, and it is more effective with long term exercise than short term exercise.

Blood vessels compliance

The artery supplies blood and has elasticity to relay the blood from the heart to the extremities. Determining factors for the compliance are elasticity of the artery, arterial wall elastin, collagen composition and functional elements of the vascular smooth muscle cells (Nicholas et al., 1993). Compliance is directly related to blood pressure, arteriosclerosis, stroke disorder (Kim, 1999). Tanaka et al. (2000) stated that aging is a determinant for compliance because it is directly related to the arteriosclerosis, but people with regular exercise has high compliance. Tanaka (2000) also stated that experiment aerobic exercise on middle and old age for 5 times a week for 13 weeks increases blood vessels compliance.

In this study, we didn't experiment only with aerobic exercise but also with a combination of strength exercise and aerobic exercise to compare the effects on compliance.

In the complex exercise focused on strength exercise, left hand and right hand of the upper extremities and left foot and right foot of the lower extremities were in no significant changes. Also, there are previous studies that athletes have lower compliance than regular individuals. Kang et al. (2012) reported that aerobic exercise for 12 weeks increases compliance by experimenting old patients with hypertension. Also, Lee and Lee (2006) reported that the compliance increased with the complex exercise. In this study, left hand, left foot, right foot were significantly increased and right foot increased by 23.27 ms, which is not significant. By looking at the result from Choi (2007), after aerobic exercise on middle aged men for 10 min, it increases by 5 ms, 20 min with 6 ms increase, and 30 min with 16 ms, aerobic exercise longer than 30 min is more effective, and one time aerobic exercise increases the responsiveness of blood vessel elasticity, but less effective than the aerobic exercise for a long time.

In this study, the aerobic exercise is more effective in compliance than the strength exercise. Also, aerobic exercise is more suitable for hypertensive patients than the strength exercise. It is highly

recommend to check the conditions of the blood vessels compliance before choosing the type of exercise based on the degree of the atherosclerosis. Furthermore, trustworthy test is necessary due to the development of standard scale and the method to evaluate.

In this study, we evaluated the changes in the body composition, blood pressure, compliance for 12 months with 29 old obese women to find the effective complex exercise rehabilitation programs. The results are below.

In the changes in body composition, it increased in the strength exercise, and decreased in aerobic exercise. The strength exercise was increased ($P = 0.003$) in weight, and decreased in the aerobic exercise ($P = 0.007$). The body fat percentage was increased in the strength exercise ($P = 0.004$) and decreased in the aerobic exercise ($P = 0.019$). The body fat was increased ($P = 0.004$) in the strength exercise, decreased in the aerobic exercise ($P = 0.033$). The abdominal obesity is increased in the strength exercise ($P = 0.002$) and decreased in the aerobic exercise ($P = 0.009$).

The strength exercise increased the systolic pressure ($P = 0.000$), but the aerobic exercise decreased the systolic pressure ($P = 0.001$). Also, the strength exercise increased the diastolic pressure ($P = 0.000$) but the aerobic exercise decreased the systolic pressure ($P = 0.000$).

Changes in compliance slightly changed or maintained in both strength exercise and aerobic exercise. While there are increases in aerobic exercises as a whole, the left foot ($P = 0.021$) and right foot ($P = 0.007$) were significantly different.

Based on these results, the aerobic focused complex exercise is more effective than the strength focused complex exercise for elderly women with obesity.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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